UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Mr. Larry Lawson, Director
Division of Water Program Coordination
Virginia Department of Environmental Quality
629 Main Street
Richmond, VA 23219

Dear Mr. Lawson:

The Environmental Protection Agency (EPA) Region III is pleased to approve the Total Maximum Daily Load (TMDL) report for the primary contact use (bacteria) impairment on Hawksbill Creek. The TMDL report was submitted to EPA for review in April 2004. The TMDL was established and submitted in accordance with Section 303(d)(1)(c) and (2) of the Clean Water Act to address an impairment of water quality as identified in Virginia's 1998 Section 303(d) list.

In accordance with Federal regulations at 40 CFR §130.7, a TMDL must comply with the following requirements: (1) designed to attain and maintain the applicable water quality standards, (2) include a total allowable loading and as appropriate, wasteload allocations (WLAs) for point sources and load allocations for nonpoint sources, (3) consider the impacts of background pollutant contributions, (4) take critical stream conditions into account (the conditions when water quality is most likely to be violated), (5) consider seasonal variations, (6) include a margin of safety (which accounts for uncertainties in the relationship between pollutant loads and instream water quality), (7) consider reasonable assurance that the TMDL can be met, and (8) be subject to public participation. The enclosure to this letter describes how the TMDL for the primary contact use impairment satisfies each of these requirements.

Following the approval of the TMDL, Virginia shall incorporate the TMDL into an appropriate Water Quality Management Plan pursuant to 40 CFR § 130.7(d)(2). As you know, all new or revised National Pollutant Discharge Elimination System permits must be consistent with the TMDL WLA pursuant to 40 CFR §122.44 (d)(1)(vii)(B). Please submit all such permits to EPA for review as per EPA's letter dated October 1, 1998.

If you have any questions or comments concerning this letter, please don't hesitate to contact Mr. Thomas Henry at (215) 814-5752.

Sincerely,

Jon M. Capacasa, Director
Water Protection Division

Enclosure

Decision Rationale

Total Maximum Daily Loads for
the Primary Contact Use (Bacteriological) Impairments on Hawksbill Creek

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA's) rationale for approving the TMDL for the primary contact use (bacteriological) impairment on Hawksbill Creek. EPA's rationale is based on the determination that the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDL is designed to implement applicable water quality standards.
2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDL considers the impacts of background pollutant contributions.
4) The TMDL considers critical environmental conditions.
5) The TMDL considers seasonal environmental variations.
6) The TMDL includes a margin of safety.
7) There is reasonable assurance that the TMDL can be met.
8) The TMDL has been subject to public participation.

II. Background

The Hawksbill Creek Watershed is located in Page County, Virginia. Hawksbill Creek is a tributary to the South Fork of the Shenandoah River. The impaired segment of Hawksbill Creek begins at its headwaters and terminates at its confluence with the South Fork of the Shenandoah River. The 57,000 acre watershed is rural with forested and agricultural lands making up 62 and 33 percent of the watershed respectively. The remainder of the watershed consists of developed lands. There are three point sources in the watershed.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed 19.3 miles of Hawksbill Creek (VAV-B39R) on Virginia's 1998 Section 303(d) list as being unable to attain its primary contact use. This decision was based on observed violations of the Commonwealth's bacteriological criteria. At the time of its listing, the bacteria criteria used fecal coliform as an indicator species and had an instantaneous standard

1,000 colony forming units (cfu) per 100 milliliters (ml) and geometric mean standard of 200 cfu/100ml. This decision rationale will address the TMDL for the impairment of the primary contact use.

Fecal coliform is a bacterium which can be found within the intestinal tract of all warm blooded animals. Fecal coliform in itself is not a pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

EPA encouraged the states to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation was drawn between the concentrations of e-coli and enterococci, and the incidence of gastrointestinal illness. The Commonwealth adopted e-coli and enterococci criteria in January 2003. According to the new criteria, streams will be evaluated via the e-coli and enterococci criteria after 12 samples have been collected using these indicator species. At least 12 e-coli samples have been collected from Hawksbill Creek. Therefore, it will be assessed according to the new criteria.

As Virginia designates all of its waters for primary contact, all waters were required to meet the bacteriological standard for primary contact. Virginia's standard applied to all streams designated as primary contact for all flows. The e-coli criteria requires a geometric mean concentration of 126 cfu/100ml of water with no sample exceeding 235 cfu/100 ml of water. Unlike the new fecal coliform criteria, which allows a 10 percent violation rate, the e-coli criteria requires the concentration of e-coli to not exceed 235 cfu/100ml of water.

Although the TMDL and criteria require the 235 cfu/100 ml of water concentration limit not be exceeded, waters are not placed on the Section 303(d) list if their violation rate does not exceed 10 percent. Therefore, Hawksbill Creek may be deemed as attaining its primary contact use prior to the implementation of all of the TMDL reductions. It is necessary to keep this in mind because of the stringent reductions required to attain the e-coli criteria in the model.

The TMDL submitted by Virginia is designed to determine the acceptable load of e-coli which can be delivered to the impaired waters, as demonstrated by the Loading Simulation Program C++ (LSPC), in order to ensure that the water quality standard is attained and maintained. LSPC is considered an appropriate model to analyze the impaired water because of its dynamic ability to simulate both watershed loading and receiving water quality over a wide range of conditions. The model was run to determine the fecal coliform loading to Hawksbill Creek as all of the loading information is based on fecal coliform. The in-stream fecal coliform concentrations are then converted to e-coli using a conversion factor established by the Commonwealth.

The TMDL analysis allocates the application/deposition of fecal coliform to land based and instream sources. For land based sources, the LSPC model accounts for the buildup and washoff of pollutants from these areas. Buildup (accumulation) refers to all of the complex

spectrum of dry-weather processes that deposit or remove (die-off) pollutants between storms.[1] Washoff is the removal of fecal coliform which occurs as a result of runoff associated with storm events. These two processes allow the LSPC model to determine the amount of fecal coliform from land based sources which is reaching the stream. Point sources and wastes deposited directly to the stream were treated as direct deposits. Wastes which are deposited directly to the stream do not need a transport mechanism.

Local rainfall and temperature data were needed to develop the model. Weather data provides the rainfall data which drives the TMDL model. Daily weather data was obtained from the Luray 5E weather station. However, in order to run the model, hourly data was needed. The daily weather data was converted into hourly data through the use of the normal-ratio method. This method uses weighted average hourly data from two nearby weather stations to determine the hourly precipitation patterns at the daily location.

Stream flow data was not available for Hawksbill Creek, therefore, a paired watershed approach was used. The hydrology model was calibrated to the observed flow collected at a United States Geological Survey (USGS) gage 01632900 located on Smith Creek. The model calibrated to two separate time periods from 1990 through 1991 and 1996 through 1997. During the calibration process, the model parameters were adjusted to more accurately simulate the observed data. The accuracy of the model is then tested in a process called validation by holding the parameters steady and assessing its simulation against a different data set. The validation was run based on a 13-year period (1990-2002). The model was then transferred to Hawksbill Creek for water quality calibrations. The water quality model was calibrated to observed data from 1991 through 1996 and validated to data from 1997 through 2002.

The TMDL was modeled using fecal coliform loading rates as was done in previous TMDL efforts. The fecal coliform concentrations were then converted to e-coli concentrations using a translator equation developed by VADEQ. Significant reductions in the modeled load were required in order for Hawksbill Creek to attain the new e-coli criteria in the model.

Table 1 - Summarizes the Specific Elements of the TMDL.

Segment	Parameter	TMDL (cfu/yr)	WLA (cfu/yr)	LA (cfu/yr)	MOS
Hawksbill Cr	E-Coli	1.87E+13	3.13E+12	1.55E+13	Implicit

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing a primary contact (bacteriological) impairment TMDL for

[1]CH2MHILL, 2000. Fecal Coliform TMDL Development for Cedar, Hall, Byers, and Hutton Creeks Virginia,

Hawksbill Creek. EPA is therefore approving this TMDL. EPA's approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

Virginia has indicated that excessive levels of fecal coliform due to nonpoint sources (both wet weather and directly deposited nonpoint sources) have caused violations of the water quality criteria and designated uses on Hawksbill Creek. The water quality criterion for fecal coliform was a geometric mean 200 cfu/100ml or an instantaneous standard of no more than 1,000 cfu/100ml. Two or more samples over a thirty-day period are required for the geometric mean standard. Since the state rarely collects more than one sample over a thirty-day period, most of the samples were measured against the instantaneous standard.

Approximately 16 percent of the samples collected from Hawksbill Creek Station 4-BHKS000.96 from September 2002 through August 2003 violated the current instantaneous criteria for e-coli. Through a process known as bacterial source tracking (BST), VADEQ was able to breakdown the sources of bacteria in these samples into four categories. The four categories were human, pets, livestock, and wildlife. Three of these four sources are anthropogenic in origin and can be controlled through a variety of management techniques. Wildlife, which may be attracted to certain areas due to anthropogenic reasons is considered a natural source of bacteria.

The BST approach used by VADEQ is known as the Antibiotic Resistance Approach (ARA), it measures the bacteria's resistance to a suite of antibiotics. The assumption is that bacteria associated with humans will have the highest resistance to antibiotics due to previous exposures to antibiotics. Livestock, pets and wildlife would all have differing resistance patterns as well. In order to conduct this work, waste samples from known sources had to have their resistance measured, this information was placed into a library. The resistance of the bacteria collected in water samples was compared to the data in the library to determine its source. According to the ARA analysis wildlife and livestock were the mains sources of bacteria.

The Commonwealth has changed its bacteriological criteria as indicated above. The new criteria require that the fecal coliform concentration not exceed a geometric mean of 200 cfu per 100 ml of water for two or more samples collected over a month nor shall more than 10 percent of the total samples exceed 400 cfu/100 ml of water. The new e-coli criteria requires a geometric mean of 126 cfu/100ml of water with no sample exceeding 235 cfu/100 ml.

The LSPC model was used to determine the fecal coliform deposition rates to the land as well as loadings to the stream from direct deposit sources. Once the existing load was

determined, allocations were assigned to each source category to develop a loading pattern that would allow Hawksbill Creek to support the e-coli water quality criterion and primary contact use. The following discussion is intended to describe how controls on the loading of e-coli to Hawksbill Creek will ensure that the criterion is attained.

The TMDL modelers determined the fecal coliform production rates within the watershed. Data used in the model was obtained from a wide array of sources, including farm practices in the area, the amount and concentration of farm animals, animal access to the stream, wildlife in the watershed, wildlife fecal production rates, landuses, weather, stream geometry, etc.. The model combined all of the data to determine the hydrology and water quality of the stream.

The lands within the watersheds were categorized into specific landuses. The landuses had specific loading rates and characteristics that were defined by the modelers. Therefore, the loading rates are different in lands defined as forested versus pasture. Pasture lands support cattle and are influenced differently by stormwater runoff.

The Hawksbill Creek TMDL model was run using weather data collected from the Luray 5E weather station. This data was used to determine the precipitation rates in the watersheds which transport the on land pollutants to the streams through overland and groundwater flows. Waste that was deposited to the land or stored was subjected to a die-off rate. The longer fecal coliform stayed on the ground the greater the die-off was. Materials that were washed off the surface shortly after deposition were subjected to less die-off.

As stated above the model for Hawksbill Creek was developed using the paired watershed approach. Since there was no gage in the Hawksbill Creek watershed, a stream with similar landuses and geologic characteristics with observed flow data was selected to develop the hydrology model. Smith Creek was selected as the paired watershed due to its similarities with Hawksbill Creek. The Smith Creek model was calibrated to flow data collected from USGS gage 01632900 from 1990 through 1991 and 1996 through 1997. The model was validated to flow data from 1990 through 2002. During the calibration period, the hydrology components of the model was adjusted in order to have the simulated (modeled) flow accurately represent the observed flow conditions. During validation, the model was then run and compared to a new set of observed flow conditions without adjusting the model parameters.

The model was then transferred to Hawksbill Creek for water quality calibration. The water quality model was calibrated to observed data from 1991 through 1996. The water quality model was then validated to data from 1997 through 2002. The loads were then reduced so that no sample would exceed the instantaneous criteria of 235 cfu/100ml and a geometric mean of 126 cfu/100ml would be attained.

2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments) and point sources. Activities that increase the levels of bacteria to the land surface or their

availability to runoff are considered flux sources. The actual value for total loading can be found in Table 1 of this document. The total allowable load is calculated on an annual basis.

Waste Load Allocations

There are three individually permitted facilities discharging bacteria to Hawksbill Creek. These facilities are required to insure that their effluent does not have an e-coli concentration in excess of 126 cfu/100ml. The three facilities were all different sizes and allowed to discharge varying amounts of effluents. Their waste load allocations (WLAs) can be determined by multiplying their allowable flow by their effluent concentration by 365 after making the appropriate unit conversions. Two of the facilities were sewage treatment plants (STPs). The WLAs for this TMDL are provided in Table 2.

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Table 2 - WLAs for Hawksbill Creek

Facility	Permit Number	Flow (gallons per day)	WLA (cfu/year)
Big Meadows STP	VA0024406	130,000	2.26E+11
Skyland Developed Area	VA0024422	70,000	1.22E+11
Luray STP	VA0062642	1,600,000	2.79E+12

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), load allocations (LAs) are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the LPSC model to represent the impaired watershed. The LPSC model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint source loadings, and receiving water quality. LSPC uses precipitation data for continuous and storm event simulation to determine total loading to the impaired segment from the various landuses within the watershed. Table 3 lists the LAs for Hawksbill Creek. The reductions needed to insure that the instantaneous criteria is attained at all times are extremely stringent. If the 10 percent violation rate required for a water to be placed on the Section 303(d) list was used as an endpoint, the reductions would not be as stringent.

Table 3a - LA for Bacteria (fecal coliform) for Hawksbill Creek

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
Livestock Direct Deposit	2.28E+13	6.85E+11	97
Wildlife Direct Deposit	6.67E+12	6.67E+12	0
Straight Pipes	1.00E+04	0.00	100
Built Up	9.32E+13	2.80E+12	97
Cropland	4.13E+13	6.85E+11	97
Pasture	9.32E+13	2.80E+12	97
Forest	1.26E+12	1.26E+12	0

3) The TMDL considers the impacts of background pollution.

The TMDL considers the impact of background pollutants by considering the bacteria load from background sources like wildlife.

4) The TMDL considers critical environmental conditions.

According to EPA's regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of Hawksbill Creek is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[2]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum.

The LSPC model was run over a multi-year period to insure that it accounted for a wide range of climatic conditions. The allocations developed in the TMDL will therefore insure that the criteria is attained over a wide range of environmental conditions including wet and dry weather conditions.

5) The TMDL considers seasonal environmental variations.

Seasonal variations involve changes in stream flow and loadings as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods.

Bacteria loadings also change during the year based on crop cycles, waste application rates, and cattle access patterns. Consistent with our discussion regarding critical conditions, the LSPC model and TMDL analysis effectively considered seasonal environmental variations through the use of observed weather data over an extended period of time and by modifying waste application rates, crop cycles, and livestock practices.

6) The TMDL includes a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account

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[2]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL. Virginia included an implicit MOS in the TMDL through the use of conservative modeling assumptions in the determination of bacteria loadings and production.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDLs can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program.

8) The TMDL has been subject to public participation.

Two public meetings were held to discuss and disseminate the Hawksbill Creek TMDL to the public. The meetings were held in the Page County Courthouse in Luray, Virginia. The meetings were held on August 26, 2003 and March 18, 2004. Approximately 50 people attended each of the meetings. The meetings and TMDLs were noticed in the Virginia Register for a thirty-day comment period and written comments were received during the second public comment period. VADEQ responded to these comments.